United Kingdom of Great Britain and Northern Ireland

EDICT OF GOVERNMENT

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BS NA EN 1998-1 (2004) (English): UK National Annex to Eurocode 8. Design of structures for earthquake resistance. General rules, seismic actions and rules for buildings

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NATIONAL ANNEX

UK National Annex to Eurocode 8: Design of structures for earthquake resistance –

Part 1: General rules, seismic actions and rules for buildings

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National Annex (informative) to BS EN 1998-1:2004, Eurocode 8: Design of structures for earthquake resistance – Part 1: General rules, seismic actions and rules for buildings

Introduction

This National Annex has been prepared by BSI Subcommittee B/525/8, *Structures in seismic regions*. In the UK it is to be used in conjunction with BS EN 1998-1:2004.

NA.1 Scope

This National Annex gives:

a) the UK decisions for the Nationally Determined Parameters described in the following subclauses of BS EN 1998-1:2004:

2.1(1)P	**5.2.2.2**(10)	**7.1.3**(4)
2.1(1)P	**5.2.4**(1),(3)	**7.7.2**(4)
3.1.1(4)	**5.4.3.5.2**(1)	**8.3**(1)
3.1.2(1)	**5.8.2**(3)	**9.2.1**(1)
3.2.1(1),(2),(3)	**5.8.2**(4)	**9.2.2**(1)
3.2.1(4)	**5.8.2**(5)	**9.2.3**(1)
3.2.1(5)	**5.11.1.3.2**(3)	**9.2.4**(1)
3.2.2.1(4), **3.2.2.2**(1)P	**5.11.1.4**	**9.3**(2)
3.2.2.3(1)P	**5.11.1.5**(2)	**9.3**(2)
3.2.2.5(4)P	**5.11.3.4**(7)e)	**9.3**(3)
4.2.3.2(8)	**6.1.2**(1)	**9.3**(4), Table 9.1
4.2.4(2)P	**6.1.3**(1)	**9.3**(4), Table 9.1
4.2.5(5)P	**6.2**(3)	**9.5.1**(5)
4.3.3.1(4)	**6.2**(7)	**9.6**(3)
4.3.3.1(8)	**6.5.5**(7)	**9.7.2**(1)
4.4.2.5(2)	**6.7.4**(2)	**9.7.2**(2)b)
4.4.3.2(2)	**7.1.2**(1)	**9.7.2**(2)c)
5.2.1(5)	**7.1.3**(1),(3)	**9.7.2**(5)
		10.3(2)P

b) the UK decisions on the status of BS EN 1998-1:2004 informative annexes; and

c) references to non-contradictory complementary information.

NA.2 Nationally Determined Parameters

UK decisions for the Nationally Determined Parameters described in BS EN 1998-1:2004 are given in Table NA.1.

Table NA.1 **UK values for Nationally Determined Parameters described in BS EN 1998-1:2004**

Subclause	Nationally Determined Parameter	Eurocode recommendation	UK decision
2.1(1)P	Reference return period T_{NCR} of seismic action for the no-collapse requirement (or, equivalently, reference probability of exceedance in 50 years, P_{NCR}).	T_{NCR} =475 years P_{NCR} =10%	In the absence of a project-specific assessment, adopt a return period T_{NCR} of 2 500 years. Further guidance is given in PD 6698.
2.1(1)P	Reference return period T_{DLR} of seismic action for the damage limitation requirement (or, equivalently, reference probability of exceedance in 10 years, P_{DLR}).	T_{DLR} =95 years P_{DLR} =10%	In the absence of a project-specific assessment, adopt the recommended values. Further guidance is given in PD 6698.
3.1.1(4)	Conditions under which ground investigations additional to those necessary for design for non-seismic actions may be omitted and default ground classification may be used.	[None]	The need for additional ground investigations shouid be established on a site-specific basis. Further guidance is given in PD 6698.
3.1.2(1)	Ground classification scheme accounting for deep geology, including values of parameters S, T_B, T_C and T_D defining horizontal and vertical elastic response spectra in accordance with BS EN 1998-1:2004, **3.2.2.2** and **3.2.2.3**.	[None]	There is no requirement to account for deep geology. Further guidance is given in PD 6698.
3.2.1(1),(2),(3)	Seismic zone maps and reference ground accelerations therein.	[None]	In the absence of a project-specific assessment, adopt the reference ground accelerations for a return period T_{NCR} of 2 500 years given by the seismic contour map in PD 6698.
3.2.1(4)	Governing parameter (identification and value) for threshold of low seismicity.	$a_g \leqslant 0{,}78 m/s^2$ or $a_g S \leqslant 0{,}98 m/s^2$	$a_g \leqslant 2 m/s^2$ (for T_{NCR} =2 500 years)
3.2.1(5)	Governing parameter (identification and value) for threshold of very low seismicity.	$a_g \leqslant 0{,}39 m/s^2$ or $a_g S \leqslant 0{,}49 m/s^2$	$a_g \leqslant 1.8 m/s^2$ (for T_{NCR} =2 500 years)

Table NA.1 **UK values for Nationally Determined Parameters described in BS EN 1998-1:2004** (*continued*)

<table>
<tr><th>Subclause</th><th>Nationally Determined Parameter</th><th>Eurocode recommendation</th><th>UK decision</th></tr>
<tr><td>3.2.2.1(4),
3.2.2.2(1)P</td><td>Parameters S, T_B, T_C, T_D defining shape of horizontal elastic response spectra.</td><td>In the absence of deep geology effects, and for Type 1 spectra (where earthquakes that contribute most to the seismic hazard defined for the site for the purpose of probabilistic hazard assessment have a surface-wave magnitude, M_s, greater than 5,5):
<table>
<tr><td>Ground type</td><td>S</td><td>T_B (s)</td><td>T_C (s)</td><td>T_D (s)</td></tr>
<tr><td>A</td><td>1,0</td><td>0,15</td><td>0,4</td><td>2,0</td></tr>
<tr><td>B</td><td>1,2</td><td>0,15</td><td>0,5</td><td>2,0</td></tr>
<tr><td>C</td><td>1,15</td><td>0,20</td><td>0,6</td><td>2,0</td></tr>
<tr><td>D</td><td>1,35</td><td>0,20</td><td>0,8</td><td>2,0</td></tr>
<tr><td>E</td><td>1,4</td><td>0,15</td><td>0,5</td><td>2,0</td></tr>
</table>
In the absence of deep geology effects, and for Type 2 spectra (where earthquakes that contribute most to the seismic hazard defined for the site for the purpose of probabilistic hazard assessment have a surface-wave magnitude, M_s, less than 5,5):
<table>
<tr><td>Ground type</td><td>S</td><td>T_B (s)</td><td>T_C (s)</td><td>T_D (s)</td></tr>
<tr><td>A</td><td>1,0</td><td>0,05</td><td>0,25</td><td>1,2</td></tr>
<tr><td>B</td><td>1,35</td><td>0,05</td><td>0,25</td><td>1,2</td></tr>
<tr><td>C</td><td>1,5</td><td>0,10</td><td>0,25</td><td>1,2</td></tr>
<tr><td>D</td><td>1,8</td><td>0,10</td><td>0,30</td><td>1,2</td></tr>
<tr><td>E</td><td>1,6</td><td>0,05</td><td>0,25</td><td>1,2</td></tr>
</table></td><td>In the absence of site-specific information, the recommended values for Type 2 earthquakes may be used, but see also PD 6698.</td></tr>
<tr><td>3.2.2.3(1)P</td><td>Parameters a_{vg}, T_B, T_C, T_D defining shape of vertical elastic response spectra.</td><td>
<table>
<tr><td>Spectrum</td><td>a_{vg}/a_g</td><td>T_B (s)</td><td>T_C (s)</td><td>T_D (s)</td></tr>
<tr><td>Type 1</td><td>0,90</td><td>0,05</td><td>0,15</td><td>1,0</td></tr>
<tr><td>Type 2</td><td>0,45</td><td>0,05</td><td>0,15</td><td>1,0</td></tr>
</table></td><td>In the absence of site-specific information, the recommended values for Type 2 earthquakes may be used, but see also PD 6698.</td></tr>
<tr><td>3.2.2.5(4)P</td><td>Lower bound factor β on design spectral values.</td><td>0,2</td><td>Use the recommended value.</td></tr>
</table>

Table NA.1 **UK values for Nationally Determined Parameters described in BS EN 1998-1:2004** (*continued*)

Subclause	Nationally Determined Parameter	Eurocode recommendation			UK decision
4.2.3.2(8)	Reference to definitions of centre of stiffness and of torsional radius in multi-storey buildings meeting or not conditions (a) and (b) of BS EN 1998-1:2004, **4.2.3.2**(8).	[None]			Any appropriate method may be used. Further guidance is given in PD 6698.
4.2.4(2)P	Ratio φ of coefficient ψ_{Ei} on variable mass used in seismic analysis to combination coefficient ψ_{2i} for quasi permanent values of variable actions.	Type of variable action	Storey	φ	Use the recommended values. Storeys occupied by different tenants may be considered as independently occupied.
		Categories A–C*	Roof	1,0	
			Storeys with correlated occupancies	0,8	
			Independently occupied storeys	0,5	
		Categories D–F* and Archives		1,0	
		* Categories as defined in BS EN 1991-1-1:2002.			
4.2.5(5)P	Importance factor γ_I for buildings.	Class I: $\gamma_I = 0,8$ Class III: $\gamma_I = 1,2$ Class IV: $\gamma_I = 1,4$			Where a value for the reference return period T_{NCR} of 2 500 years has been adopted for CC3 structures, $\gamma_I = 1$ should be assumed. Where T_{NCR} has been assessed on a project-specific basis, γ_I should also be chosen on a project-specific basis. Further guidance is given in PD 6698.
4.3.3.1(4)	Decision on whether nonlinear methods of analysis may be applied for the design of non-base-isolated buildings. Reference to information on member deformation capacities and the associated partial factors for the Ultimate Limit State for design or evaluation on the basis of nonlinear analysis methods.	[None]			No supplementary advice.

Table NA.1 **UK values for Nationally Determined Parameters described in BS EN 1998-1:2004** (*continued*)

Subclause	Nationally Determined Parameter	Eurocode recommendation	UK decision
4.3.3.1(8)	Threshold value of importance factor, γ_I, relating to the permitted use of analysis with two planar models.	[None]	3D (spatial) analysis models are recommended for all consequence class CC3 buildings.
4.4.2.5(2)	Overstrength factor γ_{Rd} for diaphragms.	For brittle failure modes, such as shear, $\gamma_{Rd} = 1,3$. For ductile failure modes, $\gamma_{Rd} = 1,1$.	Use the recommended values.
4.4.3.2(2)	Reduction factor ν for displacements at damage limitation limit state.	Class I & II: $\nu = 0,4$ Class III & IV: $\nu = 0,5$	In consequence class CC3 buildings, storey drifts should be checked against the specified limits using the recommended values of reduction factor ν.
5.2.1(5)	Geographical limitations on use of ductility classes for concrete buildings.	[None]	There are no geographical limitations.
5.2.2.2(10)	q_o-value for concrete buildings subjected to special Quality System Plan.	Adjustment to q_o-value is a factor in the range 1 to 1,2, with no recommended value within this range.	An adjustment factor of up to 1,2 on q_o is permitted if a formal quality plan is applied to the design, procurement and construction. The design quality plan should include a peer review of the seismic design and the construction quality plan should include special inspection measures for the critical (dissipative) regions.
5.2.4(1), (3)	Material partial factors for concrete buildings in the seismic design situation.	Use the γ_c and γ_s values for the persistent and transient design situations.	Use the recommended values.
5.4.3.5.2(1)	Minimum web reinforcement of large lightly reinforced concrete walls.	The minimum value for walls given in BS EN 1992-1-1:2002 and its National Annex.	Use the recommended values.
5.8.2(3)	Minimum cross-sectional width $b_{w,\,min}$ and depth $h_{w,\,min}$ of concrete foundation beams.	Buildings up to 3 storeys: $b_{w,\,min} = 0,25$m $h_{w,\,min} = 0,4$m Buildings with 4 or more storeys: $b_{w,\,min} = 0,25$m $h_{w,\,min} = 0,5$m	Use the recommended values.

Table NA.1 **UK values for Nationally Determined Parameters described in BS EN 1998-1:2004** (*continued*)

Subclause	Nationally Determined Parameter	Eurocode recommendation	UK decision
5.8.2(4)	Minimum thickness t_{min} and reinforcement ratio $\rho_{s, min}$ of concrete foundation slabs.	t_{min} = 0,2m $\rho_{s, min}$ = 0,2%	Use the recommended values.
5.8.2(5)	Minimum reinforcement ratio $\rho_{b, min}$ of concrete foundation beams.	$\rho_{b, min}$ = 0,4%	$\rho_{b, min}$ = 0,2% in top face and 0,2% in bottom face.
5.11.1.3.2(3)	Ductility class of precast wall panel systems.	DCM	Use the recommended value.
5.11.1.4	Factor k_p on q-factors of precast systems.	k_p = 1,0 for structures with connections conforming to BS EN 1998-1:2004, **5.11.2.1.1**, **5.11.2.1.2**, or **5.11.2.1.3** k_p = 0,5 for structures with other types of connection	Use the recommended values.
5.11.1.5(2)	Ratio A_p of transient seismic action assumed during erection of precast structures to design seismic action defined in BS EN 1998-1:2004, Section 3.	A_p = 0,3 unless otherwise specified by special studies	In the absence of a site-specific assessment, use the recommended value.
5.11.3.4(7)e)	Minimum longitudinal steel $\rho_{c, min}$ in grouted connections.	$\rho_{c, min}$ = 1%	Use the recommended value.
6.1.2(1)	Upper limit of q for low-dissipative structural behaviour concept.	1,5	2 Further guidance is given in PD 6698.
	Limitations on structural behaviour concept.	[None]	No limitations on structural behaviour concept. Further guidance is given in PD 6698.
	Geographical limitations on use of ductility classes for steel buildings.	[None]	No geographical limitations. Further guidance is given in PD 6698.
6.1.3(1)	Material partial factors for steel buildings in the seismic design situation.	Use the γ_s values for the persistent and transient design situations.	Use the recommended values.
6.2(3)	Overstrength factor for capacity design of steel buildings.	γ_{ov} = 1,25	Use the recommended value.

Table NA.1 **UK values for Nationally Determined Parameters described in BS EN 1998-1:2004** (*continued*)

Subclause	Nationally Determined Parameter	Eurocode recommendation	UK decision
6.2(7)	Information as to how BS EN 1993-1-10:2005 – selection of steel for fracture toughness and through thickness properties – may be used in the seismic design situation.	[None]	The fracture toughness and through thickness properties of the steel should be selected on a project-specific basis. Further guidance is given in PD 6698.
6.5.5(7)	Reference to complementary rules on acceptable connection design.	[None]	Complementary rules for connection design may be developed on a project-specific basis. Further guidance is given in PD 6698.
6.7.4(2)	Residual post-buckling resistance of compression diagonals in steel frames with *V*-bracings.	$\gamma_{pb} = 0,3$	$\gamma_{pb} = \gamma_{pb}^{*} N_{b,Rd} (\lambda bar)/ N_{pl,Rd}$ (γ_{pb}^{*} times design buckling resistance over plastic resistance) $\gamma_{pb}^{*} = 0,7$ for $q \leqslant 2$ $= 0,3$ for $q \geqslant 5$ For $2 \leqslant q \leqslant 5$, $\gamma_{pb}^{*} = 0,3$ may be assumed or refer to PD 6698. Further guidance is given in PD 6698.
7.1.2(1)	Upper limit of q for low-dissipative structural behaviour concept.	1,5	2
	Limitations on structural behaviour concept.	[None]	No limitations on structural behaviour concept.
	Geographical limitations on use of ductility classes for composite steel-concrete buildings.	[None]	No geographical limitations.
7.1.3(1),(3)	Material partial factors for composite steel-concrete buildings in the seismic design situation.	Use the γ_s values for the persistent and transient design situations.	Use the recommended values.
7.1.3(4)	Overstrength factor for capacity design of composite steel-concrete buildings.	$\gamma_{ov} = 1,25$	Use the recommended value.

Table NA.1 **UK values for Nationally Determined Parameters described in BS EN 1998-1:2004** (*continued*)

Subclause	Nationally Determined Parameter	Eurocode recommendation	UK decision
7.7.2(4)	Stiffness reduction factor for concrete part of a composite steel-concrete column section.	r=0,5	In the absence of special studies, use the recommended value.
8.3(1)	Geographical limits on ductility class for timber buildings.	[None]	No geographical limits.
9.2.1(1)	Type of masonry units with sufficient robustness.	[None]	Any type of masonry unit listed in BS EN 1996-1-1:2005, Table 3.1, is acceptable.
9.2.2(1)	Minimum strength of masonry units.	$f_{b,min}$ = 5N/mm^2 (normal to bedface) $f_{bh,min}$ = 2N/mm^2 (parallel to bedface)	Use the minimum values given in BS EN 1996-1-1:2005.
9.2.3(1)	Minimum strength of mortar in masonry buildings.	$f_{m,min}$ = 5N/mm^2 (unreinforced or confined masonry) $f_{m,min}$ = 10N/mm^2 (reinforced masonry)	Use the minimum values given in BS EN 1996-1-1:2005.
9.2.4(1)	Alternative classes for perpend joints in masonry.	[None]	Perpend joints fully grouted with mortar or ungrouted joints with mechanical interlocking between masonry units may be used. Ungrouted joints without mechanical interlock may only be used subject to appropriate validation.
9.3(2)	Conditions for use of unreinforced masonry satisfying provisions of BS EN 1996-1:2005 alone.	[None]	There are no restrictions on the use of unreinforced masonry that follows the provisions of BS EN 1996-1:2005 alone.
9.3(2)	Minimum effective thickness $t_{ef,min}$ of unreinforced masonry walls satisfying provisions of BS EN 1996-1:2005 alone.	$t_{ef,min}$ = 240 mm $t_{ef,min}$ = 170 mm in cases of low seismicity	$t_{ef,min}$ = 170 mm
9.3(3)	Maximum value of ground acceleration $a_{g,urm}$ for the use of unreinforced masonry satisfying provisions of BS EN1998-1.	$a_{g,urm}$ = 0,2 g	$a_{g,urm}$ = 0,25 g
9.3(4), Table 9.1	q-factor values in masonry buildings.	Unreinforced masonry in accordance with BS EN 1998-1: q = 1,5 Confined masonry: q = 2,0 Reinforced masonry: q = 2,5	Unreinforced masonry in accordance with BS EN 1998-1: q = 2,0 Confined masonry: q = 2,5 Reinforced masonry: q = 3,0

Table NA.1 **UK values for Nationally Determined Parameters described in BS EN 1998-1:2004** (*continued*)

Subclause	Nationally Determined Parameter	Eurocode recommendation				UK decision
9.3(4), Table 9.1	q-factors for buildings with masonry systems which provide enhanced ductility.	[None]				Enhanced values need to be justified on a case-by-case basis.
9.5.1(5)	Geometric requirements for masonry shear walls.	Masonry type	$t_{ef,min}$ (mm)	$(h_{ef}/t_{ef})_{max}$	$(l/h)_{min}$	Use the recommended values.
		Unreinforced, with natural stone units	350	9	0,5	
		Unreinforced, with any other type of units	240	12	0,4	
		Unreinforced, with any other type of units, in cases of low seismicity	170	15	0,35	
		Confined masonry	240	15	0,3	
		Reinforced masonry	240	15	No restriction	
		Symbols used have the following meaning: t_{ef} thickness of the wall (see BS EN 1996-1-1:2005); h_{ef} effective height of the wall (see BS EN 1996 1-1:2005); h greater clear height of the openings adjacent to the wall; l length of the wall.				
9.6(3)	Material partial factors in masonry buildings in the seismic design situation.	γ_m = 2/3 of value specified in National Annex to BS EN 1996-1-1:2005, but not less than 1,5 γ_s = 1,0				Use the recommended values.

Table NA.1 **UK values for Nationally Determined Parameters described in BS EN 1998-1:2004** (*continued*)

Subclause	Nationally Determined Parameter	Eurocode recommendation						UK decision
9.7.2(1)	Maximum number of storeys and minimum area of shear walls of "simple masonry building".	Acceleration at site $a_g.S$		⩽0,07 $k \cdot g$	⩽0,10 $k \cdot g$	⩽0,15 $k \cdot g$	⩽0,20 $k \cdot g$	Use the recommended values, unless justified on a project-specific basis.Further guidance is given in PD 6698.
		Type of construction	Number of storeys (n)**	Minimum sum of cross-sections areas of horizontal shear walls in each direction, as percentage of the total floor area per storey ($p_{A,min}$)				
		Unreinforced masonry	1	2,0%	2,0%	3,5%	n/a	
			2	2,0%	2,5%	5,0%	n/a	
			3	3,0%	5,0%	n/a	n/a	
			4	5,0%	n/a*	n/a	n/a	
		Confined masonry	2	2,0%	2,5%	3,0%	3,5%	
			3	2,0%	3,0%	4,0%	n/a	
			4	4,0%	5,0%	n/a	n/a	
			5	6,0%	n/a	n/a	n/a	
		Reinforced masonry	2	2,0%	2,0%	2,0%	3,5%	
			3	2,0%	2,0%	3,0%	5,0%	
			4	3,0%	4,0%	5,0%	n/a	
			5	4,0%	5,0%	n/a	n/a	
		* n/a means "not acceptable". ** Roof space above full storeys is not included in the number of storeys.						
9.7.2(2)b)	Minimum aspect ratio in plan λ_{min} of "simple masonry buildings".	λ_{min} = 0,25						Use the recommended value.
9.7.2(2)c)	Maximum floor area of recesses in plan for "simple masonry buildings", expressed as a percentage p_{max} of the total floor plan area above the level considered.	p_{max} = 15%						Use the recommended value.
9.7.2(5)	Maximum difference in mass $\Delta_{m,\,max}$ and wall area $\Delta_{A,\,max}$ between adjacent storeys of "simple masonry buildings".	$\Delta_{m,\,max}$ = 20% $\Delta_{A,\,max}$ = 20%						Use the recommended values.
10.3(2)P	Magnification factor γ_x on seismic displacements for isolation devices.	γ_x = 1,2 for buildings						γ_x = 1,5 for buildings

NA.3 Decisions on the status of the informative annexes

NA.3.1 Elastic displacement response spectrum [BS EN 1998-1:2004, Annex A]

BS EN 1998-1:2004 informative Annex A should not be used in the UK. Further guidance is given in PD 6698.

NA.3.2 Determination of the target displacement for nonlinear static (pushover) analysis [BS EN 1998-1:2004, Annex B]

BS EN 1998-1:2004 informative Annex B may be used in the UK as an informative annex. Further guidance is given in PD 6698.

NA.4 References to non-contradictory complementary information

The following is a list of references that contain non-contradictory complementary information for use with BS EN 1998-1:2004.

- PD 6698:2008, *Background paper to the UK National Annexes to BS EN 1998-1, BS EN 1998-2, BS EN 1998-4, BS EN 1998-5 and BS EN 1998-6*;
- *Manual for the seismic design of steel and concrete buildings to Eurocode 8*. Institution of Structural Engineers, London. In draft; publication expected 2008.

Bibliography

Standards publications

BS EN 1993-1-10:2005, *Eurocode 3 – Design of steel structures – Part 1-10: Material toughness and through-thickness properties*

BS EN 1996-1-1:2005, *Eurocode 6 – Design of masonry structures – Part 1-1: General rules for reinforced and unreinforced masonry structures*

BS EN 1998-1:2004, *Eurocode 8 – Design of structures for earthquake resistance – Part 1: General rules, seismic actions and rules for buildings*

PD 6698:2008, *Background paper to the UK National Annexes to BS EN 1998-1, BS EN 1998-2, BS EN 1998-4, BS EN 1998-5 and BS EN 1998-6*

Other publications

[1] Institution of Structural Engineers: *Manual for the seismic design of steel and concrete buildings to Eurocode 8*, London: publication expected 2008.

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